Cattle farmers' preferences for Disease Free Zones in Kenya: An application of the choice experiment method

David Jakinda Otieno, Eric Ruto and Lionel Hubbard[1]

Abstract

Management of livestock diseases is important in ensuring food safety to consumers in both domestic and export markets. Various measures are prescribed under the Sanitary and Phytosanitary Standards (SPS) agreement of the World Trade Organization. In order to prevent spread of trans-boundary cattle diseases, the SPS agreement recommends establishment of Disease Free Zones (DFZs). These have been implemented successfully in some major beef exporting countries, but in Kenya are still at a pilot stage. To understand Kenyan farmers' preferences on the type of DFZ that would be readily acceptable to them, a choice experiment was conducted using a D-optimal design. Results show that farmers would be willing to pay to participate in a DFZ where: adequate training is provided on pasture development, record keeping and disease monitoring; market information is provided and sales contract opportunities are guaranteed; cattle are properly labelled for ease of identification; some monetary compensation is provided in the event that cattle die due to severe disease outbreaks. Preferences for the DFZ attributes are shown to be heterogeneous across three cattle production systems. We also derive farmers' preferences for various DFZ policy scenarios. The findings have important implications for policy on the design of DFZ programmes in Kenya and other countries that face similar cattle disease challenges.

Key words: Farmer preferences; Disease Free Zone; policy; choice experiment; random parameter logit; Kenya.

JEL classifications: C25, O21, Q17, Q57

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1 Introduction

Production and trade in cattle is an important source of livelihood for many people in various parts of the world, including Kenya where the livestock sector contributes about 42 percent of total agricultural output (KIPPRA, 2009). However, frequent outbreaks of trans-boundary cattle diseases in the country, especially Foot and Mouth Disease (FMD), often cause considerable losses (Otieno, 2008). Disease-endemic status, in addition to other supply-side constraints, means that Kenya has lost major export markets for beef (e.g., Japan) and is unable to utilise preferential market access to the European Union (EU) (Gitu, 2005). Disease control is also of considerable concern to the domestic market to safeguard consumers from food-borne illnesses and to enable traders to expand sales in middle and high income population segments (Narrod *et al*., 2008).

In order to contain the spread of four main trans-boundary cattle diseases that the World Organization for Animal Health (OIE) officially recognises as being of considerable economic importance - FMD, Contagious Bovine Pleuropneumonia (CBP), Bovine Spongiform Encephalopathy (BSE) and Rinderpest - various measures are prescribed under the Sanitary and Phytosanitary Standards (SPS) agreement of the World Trade Organization (WTO). With regard to food safety in livestock trade, the SPS agreement recommends establishment of Disease Free Zones (DFZs) (WTO, 1995a). A DFZ may be described as a programme whereby an area or country is demarcated into sub-units on the basis of the level of cattle disease incidence with various disease control strategies being applied in the different sub-units. Disease zoning or regionalisation may be used to separate a diseased area in an otherwise disease-free country, or as a way to secure a disease-free area in an otherwise infected country (Zepeda *et al*., 2005). In order to ensure that the DFZ is effective in assuring a safe and more stable beef supply, producer compliance with regulations is mandatory. Otherwise, the demarcation may create a price differential and provide an incentive for farmers to smuggle cattle from a lower-priced infected region to a higher-priced disease-free area during a disease outbreak. This may lead to eventual collapse of the DFZ programme (Loppacher *et al*., 2006).

As a disease control strategy, DFZs have been successfully implemented in some major beef exporting countries such as Australia, Botswana, Brazil and Namibia. In Kenya, however, the design of DFZs is still at a pilot stage and focuses mainly on rehabilitation of previous livestock holding grounds, upgrading of abattoirs and separation of wildlife from livestock ranches (Republic of Kenya, 2008). Information on farmers' preferences on the features that they would like to be included in a DFZ is useful to policy-makers on two grounds: to enable assessment of potential acceptability of the DFZ programme; to provide insights on some of the issues that may affect implementation of the DFZ, especially considering differences in production systems and relative resource endowments between farmers in Kenya and elsewhere.

We use a choice experiment (CE) (Louviere, 2001) to investigate farmers' preferences for key attributes in the design of a DFZ policy. A CE is a stated preference approach for *ex-ante* analysis of preferences for goods/services (e.g., DFZs) that are not yet in the market and would therefore not be possible to evaluate using revealed preference methods (Louviere *et al*., 2000). Furthermore, CE is preferred over other stated preference techniques, such as contingent valuation (CV) (Mitchell and Carson, 1989), because it enables evaluation of trade-offs for various components (attribute levels) of a good/service rather than the good/service *per se* (Hanley *et al*., 2001).

Choice experiments have been applied to value quality changes in environmental attributes (e.g. Adamowicz *et al.*, 1998; Willis *et al*., 2002), to estimate farmers' preferences for genetic attributes of indigenous livestock (Roessler *et al*., 2008; Ruto *et al*., 2008), and to investigate cow-calf producer preferences for alternative voluntary traceability systems (Schulz and Tonsor, 2010). A notable development is in the use of CEs to inform the design of policies or programmes (Hanley *et al*., 2003; Ruto and Garrod, 2009; Espinosa-Goded *et al*., 2010). Following this approach, we employ a CE to estimate beef cattle farmers' preferences for key elements of DFZ *policy design* and, particularly, to investigate the trade-offs that farmers are willing to make between various attributes of the DFZ. To the best of our knowledge, such an analysis has not been addressed in the literature.

The remainder of the paper is organized in four sections. Section two discusses the CE design and data collection approach. In section three the choice model applied in data analysis is presented, while the fourth section reports the findings of the study. Some key conclusions are offered in section five.

2 Choice experiment design and data collection

2.1 Choice experiment design

We conceptualise DFZs to have two types of attributes or features: compulsory; optional or voluntary. The compulsory attributes are those that must be adhered to by all farmers in the DFZ and all other people living in the neighbourhood (but not necessarily members of the DFZ), in order to prevent spread of diseases. The compulsory features are necessary to enforce public policy (Olson, 1965) and include: controlled grazing; regular monitoring and prompt reporting of disease occurrence to veterinary officers; no movement of animals to or from a DFZ during a disease outbreak; slaughter and safe disposal of all infected cattle in case of an outbreak. The optional or voluntary features are those that allow farmers some choice and are the ones that enter the CE design. These features enable individuals with diverse interests to exercise collective action, which Ostrom (1990) notes is necessary when individuals face a common problem, such as cattle disease, that may threaten their collective livelihoods.

Our CE design process began with identification of policy-relevant DFZ features through a review of the literature on DFZ implementation in other countries (for example, see Mapitse, 2008), in-depth interviews of key officials of the Ministry of Livestock Development in Kenya, and focus group discussions with farmers. Following guidelines proposed by Bateman *et al.* (2002), the focus group discussions were also used to validate important attributes identified and their levels for inclusion in the CE. Five DFZ attributes were selected for the CE design from the validation exercise: training of farmers on pasture development, monitoring and reporting of disease occurrence; provision of market support; compensation to farmers; labelling of cattle for ease of traceability; an annual membership fee (cost) per animal.

Due to differences in levels of access to livestock extension and veterinary advisory services in Kenya, it was envisaged that some farmers would need *training* in order to fully comply with the compulsory DFZ requirements, such as disease monitoring and reporting. Moreover, provision of *market support* would enable farmers to earn better incomes and sustain their long term participation in the programme. A *compensation* scheme (in case of a fatal disease outbreak) would act as an incentive to boost farmers' participation.[2] The maximum level of compensation used in the study (50 percent of the value of cattle lost) is consistent with the allowable domestic farm support measures in articles 7 and 8 of Annex 2 (the green box) in the WTO Agreement on Agriculture (AoA). In the AoA, compensation of farmers for losses of income or livestock from natural disasters e.g., disease outbreaks, should not exceed 70 percent (WTO, 1995b). *Labelling* of cattle is considered important for enhancing traceability. Finally, payment of a *membership fee* would guarantee farmers' access to veterinary drugs and services in the DFZ at all times without any extra charges, and would also enhance financial sustainability of the programme, given that governments in developing countries such as Kenya are unlikely to be able to provide full funding for DFZs. Following recommendations from the focus group discussions, three levels were used for each of the five DFZ attributes, except training for which only two levels were used (Table 1).

[2] Currently such a scheme does not exist in Kenya and farmers usually loose substantially from disease outbreaks.

Table 1: Attributes included in DFZ choice experiment design

DFZ attribute	**Attribute levels**
Training	No Training Training is provided
Market support	No market support Market information is provided Market information is provided and contract sale is guaranteed
Compensation	10 per cent of the value of cattle lost 25 per cent of the value of cattle lost 50 per cent of the value of cattle lost
Labelling of cattle	No labelling Labelling cattle without owner's identity Labelling cattle with owner's identity
Annual membership fee per animal (in Kenyan shillings; Kshs)	150 300 450

In CE design, different experimental procedures can significantly influence the accuracy of the results. Generally, it is important to use an experimental design approach that maximises an efficiency criterion (such as D-efficiency), or equivalently, minimises an error criterion such as the D-error. A design is said to be *D-efficient* or *D-optimal* if it has a sufficiently low D-error or yields data that enable estimation of parameters with low standard errors (see Scarpa and Rose, 2008 for details). Given the large geographical scope of the study and the cost of surveys of this kind, sample size was also an important issue. To increase sampling efficiency, we focused on maximising the *D-optimality* through a two-stage design procedure (Bliemer and Rose, 2010). First, a conventional fractional factorial orthogonal design was used in a preliminary survey of 36 farmers to obtain prior coefficients. These *priors* were then used in the second stage to generate an efficient design, which had a relatively good level of *D-optimality* (i.e., *D-efficiency* measure of 85 percent). In addition, the design had good utility balance (i.e., a *B-estimate* of 77 percent), which indicates there was an insignificant likelihood of dominance by any alternative in the choice situations (Huber and Zwerina, 1996). The final design had 24 paired choice profiles that were randomly blocked into six sets of four choice tasks. Respondents were randomly assigned to one of the six sets. Each choice task consisted of two alternatives (A and B) and a baseline alternative (C) in which all DFZ attributes were set at the 'zero level'. When making choices, respondents were asked to consider only the attributes presented in the choice tasks and to treat each choice task independently. An example of a choice set presented to respondents is shown in Figure 1. Overall, our design, generated using the statistical software NGENE (ChoiceMetrics, 2009), is in line with the optimum CE design dimensions discussed in Caussade *et al.* (2005). Pilot testing of the CE questionnaire was conducted through face-to-face interviews of a further 36 farmers to refine its wording and format. The pilot survey showed that respondents could comfortably handle at least four choice tasks.

Figure 1: Example DFZ choice set

We would like you to choose your most preferred type of DFZ from the following three alternatives.			
DFZ Attribute	**Alternative A**	**Alternative B**	**Alternative C**
Training	Training is provided	No training	No training
Market support	No market support	Market information and contract	No market support
Compensation	25%	10%	No compensation
Labelling	Cattle and owner	No labelling	No labelling
Annual membership fee (Kshs)	150	450	No membership fee
Which ONE would you prefer?			

2.2 Data collection

The study was conducted in four sites (Kajiado, Kilifi, Makueni and Taita Taveta districts) that are representative of Kenya's three main cattle production systems: nomadic pastoralism; agro-pastoralism; ranches. Nomadic pastoralists generally migrate seasonally with cattle in search for pasture and water. They are less commercialised, but derive a relatively large share of their livelihood from cattle and other livestock. In contrast, the agro-pastoralists are sedentary; they keep cattle and other livestock, besides cultivating various crops, and are fairly commercialised. Ranchers are also sedentary and operate purely commercial livestock enterprises; they may also grow crops for use as on-farm fodder or for sale (Omiti and Irungu, 2002). Whereas the ranchers mainly use controlled grazing on their private land, the nomads and agro-pastoralists generally practice an open grazing system, which tends to cause conflicts with other land users when cattle encroach on private or public protected land. Recently, many conflicts arising from encroachment have led to confiscation of cattle or penalties such as fines (Obunde *et al*., 2005). It is important to understand how different grazing systems might influence preference for DFZ attributes, particularly labelling of cattle (which would indirectly deter trespass). In addition, differences in relative disease incidence might also explain preferences for DFZ features in the three production systems. Cattle disease incidence generally varies with the level of migration and, in Kenya, is estimated to be 60 percent, 40 percent and 25 percent in nomadic, agro-pastoral and ranch systems, respectively (Maloo *et al*., 2001). The areas sampled in the study represent different agro-ecological zones, but are contiguous, hence logistically more accessible.

A multi-stage cluster (area) sampling approach (Horppila and Peltonen, 1992) was used. Within the four districts, smaller administrative units (divisions) were randomly selected from lists of all divisions in these districts, taking into account the general distribution of cattle in the study area. Subsequent stages involved a random selection of a sample of locations, from which a number of smaller units (sub-locations) were selected. The primary sampling units for the survey were therefore restricted to 40 sub-locations. Systematic random sampling was used to select individual respondents for interview during the survey. With the assistance of local interviewers experienced in surveys, the CE questionnaire was administered through face-to-face interviews of farmers in local languages between July and December 2009. A random route procedure (for example first left, next right, and so on) was followed by the interviewers to select every fifth or tenth farmer, in sparsely or densely populated sub-locations, respectively. In total, 313 farmers, including 66 ranchers, 110 nomadic pastoralists and 137 agro-pastoralists, were interviewed.

3 Model specification

The conceptual framework of a CE derives from Lancaster's theory of consumer choice (Lancaster, 1966) which postulates that preferences for goods are a function of the attributes of the goods rather than the goods themselves. The analysis of CE data follows the behavioural framework of random utility theory (McFadden 1973; Ben-Akiva and Lerman, 1985), which describes discrete choices in a utility maximising framework. We apply the random parameter logit (RPL) model in the analysis[3].

The RPL (also called mixed logit model) provides a flexible and computationally practical method for analysing results from CE surveys (McFadden and Train 2000; Train 1998). The model addresses three limitations of the standard multinomial logit (MNL) model by allowing: (a) random taste variation and hence explicitly accounting for heterogeneity in preferences; (b) unrestricted substitution patterns; (c) dependence across a panel of repeated choices made by the same respondent, which captures correlation in unobserved factors that affect individual utility. The RPL is also not subject to the strong assumption of independence of irrelevant alternatives (IIA) property (Hausman and McFadden, 1984) inherent in the standard MNL. The specification and estimation of the RPL model follows Revelt and Train (1998), to which the reader is referred for detail.

Each respondent is presented with a series of T=4 choices. In each choice set, a respondent faces a choice between J=2 alternatives (plus a baseline option). Thus, the three alternatives that the respondent faces in a particular choice set comprise two DFZ policy options described in terms of key design attributes (training, market information, compensation, etc.) and the option in which none of the attributes is available. The attributes of alternative i in choice occasion t faced by respondent n are collectively labelled as vector X_{int}. The utility obtained by individual n from alternative i in choice situation t is expressed as:

$$U_{\text{int}} = \beta_n X_{\text{int}} + \varepsilon_{\text{int}} \qquad (1)$$

where the coefficient vector for each respondent β_n is unobserved and varies in the population with a density function $f(\beta_n \mid \theta)$, whereby θ are the parameters of this distribution. ε_{int} is an unobserved random term assumed to be identically independently distributed (IID) Type I extreme-value. Conditional on β_n, the probability that individual n chooses alternative i in choice situation t is given by the standard MNL model:

$$L_{\text{int}}(\beta_n) = \frac{\exp(\beta_n X_{\text{int}})}{\sum_{j \in C} \exp(\beta_n X_{jnt})} \qquad (2)$$

Let $i(n,t)$ denote the alternative chosen by individual n in choice situation t. The probability of individual n's observed sequence of choices (conditional on β_n) is simply the product of the standard MNL model assuming that the individual tastes, β_n, do not vary over choice situations in repeated choice tasks (though are assumed heterogeneous over individuals):

$$G_n(\beta_n) = \prod_t L_{\text{int}}(\beta_n) \qquad (3)$$

The unconditional probability for the sequence of choices made by individual n is expressed as:

$$P_n(\theta) = \int G_n(\beta_n) f(\beta_n | \theta) d\beta_n \qquad (4)$$

Two sets of parameters are noteworthy in this expression: β_n is a vector of parameters specific to individual n (representing the individual's tastes, which vary between respondents) and θ are parameters that describe the distribution of the individual-specific estimates (such as the mean and covariance of β_n). The objective in RPL is to estimate the θ. This is usually done through simulation

[3] Either the RPL or latent class model (LCM) could be used to investigate preference heterogeneity. There are no theoretical grounds for the choice of one over the other (Greene and Hensher, 2003). We explored both approaches, but found the RPL to fit the sample data better.

of the choice probability (because the integral in Equation 4 cannot be computed analytically due to the lack of a closed mathematical form). The log-likelihood function is specified as:

$$LL(\theta) = \sum_n \ln P_n(\theta) \tag{5}$$

The $P_n(\theta)$ is approximated by a summation over randomly chosen values of β_n. For a selected value of the parameters θ, a value of β_n is drawn from its distribution and $G_n(\beta_n)$, i.e., the product of the standard MNL model, is computed. Repeated calculations are done for several draws and the average of the $G_n(\beta_n)$ is considered as the approximate choice probability:

$$SP_n(\theta) = \left(\frac{1}{R}\right)\sum_{r=1}^{R} G_n\left(\beta_n^{\,r|\theta}\right) \tag{6}$$

where R is the number of draws of β_n, $\beta_n^{r|\theta}$ is the *r-th* draw from $f(\beta_n | \theta)$ and SP_n is the simulated probability of individual *n*'s sequence of choices. Following Train (2003), the simulation was based on Halton intelligent draws, which has been shown to yield more accurate results compared to independent random draws. Up to 100 Halton draws were used in the simulations. The simulated log-likelihood function is constructed as:

$$SLL(\theta) = \sum_n \ln\left(SP_n(\theta)\right) \tag{7}$$

The estimated parameters are those that maximize $SLL(\theta)$. Trade-offs between DFZ attributes and money, i.e., the marginal willingness to pay (WTP), are computed as (Hanemann, 1984):

$$WTP = -1 * \left(\frac{\beta_k}{\beta_p}\right) \tag{8}$$

where β_k is the estimated coefficient for an attribute level in the choice set and β_p is the marginal utility of income given by the coefficient of the farmer's membership fee (cost attribute). The marginal WTP (implicit price) for a discrete change in an attribute provides a measure of the relative importance that respondents attach to attributes within the DFZ design. Finally, the overall WTP or compensating surplus (CS) welfare measure can be obtained for different DFZ policy scenarios associated with multiple changes in attribute levels as:

$$CS = \frac{-1}{\beta_p}(V_1 - V_0) \tag{9}$$

where V_1 represent the value of the indirect utility associated with attributes of the DFZ scenario under consideration, while V_0 is the indirect utility of the baseline scenario of no DFZ.

4 Results and discussion

4.1 Farmer characteristics

Descriptive results show that ranchers, on average, have much larger herds and farms than the nomads and agro-pastoralists. However, a high proportion of each type experiences disease-related cattle losses; about three-quarters for nomads and ranchers and half for agro-pastoralists (Table 2). As a consequence, a DFZ may be a beneficial intervention. In addition, it might be expected that the high disease incidence in nomadic systems, and the greater losses incurred by both nomads and ranchers from diseases, would lead to higher preference for DFZs by these two groups.

Currently, ranchers benefit from relatively better access to livestock extension and veterinary advisory services, and have significantly higher household incomes, than nomads and agro-pastoralists. In common with the nomads, they depend more heavily on cattle as the main source of income and tend to keep indigenous (local) cattle breeds such as the *Zebu* and *Boran*, which are relatively well adapted to dry areas. In contrast, the agro-pastoralists have a majority of exotic and crossbreeds. In terms of main market outlet, between a half (nomads) and three-quarters (ranchers) of farmers opt for slaughterhouses in preference to open air markets, neighbours or other channels (Table 2). Across all three production systems, a higher proportion of farmers use slaughterhouses for their indigenous cattle than for their exotic and crossbreeds; this difference is most noticeable for the nomads.

There is no significant difference in the average age of agro-pastoralists and ranchers, but generally farmers in both categories are slightly older than the nomads. Across all three production systems, less than 40 percent of respondents have formal education at the secondary level or above (Table 2).

Table 2: Sample characteristics

Characteristic	Nomads (n = 110)	Agro-pastoralists (n = 137)	Ranchers (n = 66)	Pooled sample (n = 313)
Average herd size	53.1^{b}	11.4^{c}	150.9^{a}	55.5
Average farm size (acres)	84.1^{b}	9.5^{c}	426.5^{a}	123.6
Loss of cattle from diseases (% of farmers affected in the past year)	74.5^{a}	49.6^{b}	72.7^{a}	63.3
Access to livestock extension services (% of farmers)	49.1^{b}	35.8^{c}	77.3^{a}	49.2
Access to veterinary advisory services (% of farmers)	50.0^{b}	51.8^{b}	87.9^{a}	58.8
Percentage of farmers who derive more than half of income from cattle	78.2^{b}	36.5^{c}	93.9^{a}	63.3
Main cattle breed is indigenous (% of farmers)	68.2^{a}	27.0^{c}	54.5^{b}	47.3
Slaughterhouse as main market outlet (% of farmers)	49.1^{c}	64.2^{b}	77.3^{a}	61.7
Sale of indigenous breed in slaughterhouses (% of farmers)	80.0^{a}	67.0^{a}	80.0^{a}	72.1
Sale of exotic or crossbreeds in slaughterhouses (% of farmers)	34.7^{c}	56.8^{b}	75.0^{a}	50.0
Monthly household income above Kshs 20, 000 (% of farmers)	22.7^{b}	15.3^{b}	84.8^{a}	32.6
Average age of respondent (years)	38.6^{b}	42.4^{a}	42.1^{a}	41.0
Secondary education and above (% of farmers)	30.0^{a}	38.7^{a}	34.8^{a}	34.8

^{a,b,c} differences in the superscripts denote significant differences (at 10% level or better) across the production systems.

4.2 Empirical Estimation

The variables used in the DFZ analysis and their coding are shown in Table 3. A likelihood ratio test shows that parameters are not equal across production systems.[4] The utility parameters for all DFZ attributes were entered as random parameters assuming a normal distribution, except the cost attribute which was specified as fixed so as to facilitate estimation of the distribution of WTP, by eliminating the risk of obtaining extreme negative and positive trade-off values (Revelt and Train, 1998; Campbell *et al*., 2010).

Table 3: Description of variables used in the choice analysis

Variable	Description
TRAIN	Training is provided (1 = Yes; 0 otherwise)
MKI	Market information is provided (1 = Yes; 0 otherwise)
MKIC	Market information is provided and sales contract is guaranteed (1 = Yes; 0 otherwise)
COMPEN	Compensation (10%, 25% or 50%)
LABC	Label cattle only (1 = Yes; 0 otherwise)
LABCO	Label cattle with owner's identity (1 = Yes; 0 otherwise)
COST	Annual membership fee per animal (150, 300 or 450)

Results of the RPL models for the three production systems and the pooled sample are reported in Table 4. Farmers prefer training on pasture development, monitoring and reporting of cattle diseases. This result may capture farmers' lack of satisfaction with the current livestock extension service provision system and also corroborates the suggestion by Irungu *et al.* (2006) that livestock farmers prefer community-based animal health workers because of a high proportion of poorly trained veterinary officers in remote areas of Kenya. As expected, preferences for the market support attributes are fully consistent with the choice axiom of transitivity; market information and contract is preferred to market information only or to no market support. The estimated coefficient for compensation is also positive, as expected, and significant. There is a higher preference for labelling cattle without, rather than with, the owner's identity. This might be due to farmers' fear of penalties (e.g., fines) that are normally imposed on those who practice open grazing and encroach on private or public protected farms. However, as noted by Schulz and Tonsor (2010), acceptance of a complete system of cattle labelling by most farmers would be useful for verification of animal health, as well as for market access purposes. The parameter estimate for farmers' annual membership fee (COST) is significant with the expected negative sign, which permits computation of trade-offs between each attribute and money.

[4] The likelihood ratio (LR) statistic is calculated as $-2\{L(\text{pooled}) - (L1+L2+L3)\}$ where L(pooled) is the value of the log likelihood function for the pooled sample, while L1, L2 and L3 are the values of the log likelihood for the sub-samples (nomads, agro-pastoralists and ranchers, respectively). The LR statistic is distributed chi-square with degrees of freedom equal to the number of parameters estimated. The test strongly rejects the hypothesis that the parameters are equal across the three production systems, with a LR statistic of 68.54 compared to the chi-square critical value of 18.48 at 1% level and 7 degrees of freedom. All the model estimations were carried out using LIMDEP version 9.0/NLOGIT version 4.0 software (Greene, 2007).

Table 4: Random parameter logit estimates for DFZ attributes

Variable	Coefficient (t-ratio)			
	Nomads	Agro pastoralists	Ranchers	Pooled sample
TRAIN	4.85 (5.76)***	6.67 (5.47)***	5.11 (3.97)***	4.36 (9.69)***
MKI	3.11 (4.64)***	4.38 (5.34)***	3.27 (3.09)***	3.01 (7.83)***
MKIC	3.78 (4.90)***	5.03 (5.18)***	5.31 (3.73)***	3.50 (8.76)***
COMPEN	0.06 (3.93)***	0.06 (3.53)***	0.06 (3.05)***	0.05 (6.28)***
LABC	2.27 (2.77)***	0.46 (0.88)	1.27 (1.44)	1.17 (3.67)***
LABCO	1.43 (3.01)***	0.32 (0.66)	2.39 (3.17)***	0.98 (4.25)***
COST	-0.004 (-3.27)***	-0.011 (-5.14)***	-0.005 (-2.91)***	-0.005 (-7.21)***
Standard deviations of parameter distributions (t-ratio)				
sdTRAIN	2.58 (4.23)***	3.02 (4.02)***	2.44 (2.74)***	2.15 (7.21)***
sdMKI	0.40 (0.45)	3.13 (3.46)***	1.98 (2.19)**	1.35 (2.79)***
sdMKIC	1.52 (1.95)*	2.13 (2.86)***	2.39 (2.78)***	1.48 (3.85)***
sdCOMPEN	0.04 (2.51)**	0.03 (1.79)*	0.03 (1.05)	0.04 (3.32)***
sdLABC	0.12 (0.10)	0.31 (0.46)	0.23 (0.21)	0.17 (0.70)
sdLABCO	1.00 (1.34)	1.20 (1.63)	0.48 (0.64)	0.57 (0.18)
Log-likelihood	-179.99	-253.65	-115.12	-577.43
Adjusted pseudo-R^2	0.40	0.36	0.35	0.35
n (respondents)	110	137	66	313
n (choices)	440	548	264	1,252

Notes: Statistical significance levels: ***1%; **5%; *10%. Corresponding t-ratios are shown in parentheses.

The estimated models for the separate production systems, as well as the pooled sample, all exhibit good explanatory power (pseudo-R^2 values between 35 percent and 40 percent). All the attribute coefficients (except labelling cattle with or without owner's identity) have highly significant standard deviations, implying that there are, indeed, heterogeneous preferences for these attributes. The estimated means and standard deviations of the normally distributed coefficients also provide information on the probability distribution of the population according to the proportion that places a positive value on a particular attribute and the proportion that places a negative value on it. Generally, over 90% of farmers had a positive preference for each of the attributes included in the CE. Somewhat unexpected is a small proportion (around 9%) that had a negative preference for compensation, but this may be an artefact of the normal distribution. A majority of farmers clearly preferred the DFZ attributes included in the CE, suggesting that collectively these attributes fully captured respondents' preference range for DFZs.

The WTP results confirm that farmers have heterogeneous preferences for all the DFZ attributes (Table 5). In the pooled sample, farmers are willing to pay between Kshs 733 and Kshs 900 per animal annually for inclusion of training in a DFZ (less than 10% of the value of an animal); Kshs 491 to Kshs 638 for provision of market information only; Kshs 580 to Kshs 731 for provision of market information and sales contract guarantee; Kshs 8 to Kshs 11 for compensation per one percent of the value of cattle lost due to a disease occurrence; Kshs 159 to Kshs 279 for labelling of cattle without showing owner's identity; and Kshs 140 to Kshs 229 with owner's identity[5]. On the basis of the WTP values, farmers' ranking of preferences is: training; market

[5] The estimated WTP values for all the DFZ attributes seem reasonable, given that average prices of cattle in the study sites at the time of survey were between Kshs 10,000 and Kshs 30,000. Cattle prices in Kenya generally vary depending on the animal body condition, breed, type of market and purpose of buying, amongst other factors (Randeny *et al.*, 2006).

information and contract; market information only; labelling cattle only; and labelling cattle with owner's identity.[6]

Table 5: Marginal WTP estimates for DFZ attributes (Kshs)*

Variable	Marginal WTP (95% confidence interval)			
	Nomads	Agro-pastoralists	Ranchers	Pooled sample
TRAIN	1,273.2	596.6	1,038.4	816.3
	(938.0 – 1,608.0)$^{\xi}$	(532.7 – 660.4)	(768.5 – 1,308.4)	(732.7 – 899.9)
MKI	815.3	391.8	660.6	564.5
	(577.0 – 1,053.5)	(331.9 – 451.7)	(435.7 – 885.5)	(491.2 – 637.8)
MKIC	994.4	450.0	1,072.7	655.3
	(715.0 – 1,273.7)	(395.4 – 504.6)	(773.9 – 1,371.4)	(579.6 – 731.0)
COMPEN	15.0	5.6	12.3	9.1
	(10.3 – 19.7)	(4.4 – 6.8)	(8.6 – 16.0)	(7.7 – 10.5)
LABC	595.0	41.2 $^{\Psi}$	257.2	218.9
	(363.5 – 826.5)	(-5.1 – 87.4)	(73.6 – 440.8)	(159.2 – 278.6)
LABCO	376.4	28.7 $^{\Psi}$	481.9	184.1
	(239.7 – 513.0)	(-15.6 – 73.1)	(316.0 – 647.9)	(139.5 – 228.7)

Notes: $^{\Psi}$ not significant at 5% level.
$^{\xi}$ confidence intervals have been calculated from standard errors estimated using the delta method in LIMDEP version 9.0/NLOGIT version 4.0 (Greene, 2007).
* Average prices of cattle in the study sites at the time of survey were between Kshs 10,000 and Kshs 30,000.

On average, nomads and ranchers are willing to pay relatively more than the agro-pastoralists for *training*, to enable them to implement some of the requirements of the DFZ, such as monitoring and reporting of disease occurrence. This may reflect differences in current access to livestock extension and veterinary advisory services (see Table 2) and, for the nomads, limited opportunities of acquiring cattle production skills in formal livestock-specific training schemes. However, all three farmer types exhibit preference for training in the DFZ, which might suggest that the existing formal education and livestock development programmes are inadequate. As expected, the inclusion of *contract guarantee* in *market support* raises the WTP across all production systems. The agro-pastoralists' lower WTP for *compensation* may indicate that, in the absence of compensation, they would still be able to achieve reasonable returns from their more diversified enterprises, compared to the nomads and ranchers. The results also show that agro-pastoralists do not prefer *labelling* of cattle with or without the owner's identity. This could be associated with their small farms, hence a preference to continue practicing open grazing (while concealing identity to avoid penalties in case of encroachment/trespass). Similarly, the nomads would be willing to pay more for labelling cattle only than for labelling with owner's identity, perhaps implying that they, too, prefer some degree of open grazing and anonymity. In order to prevent infection of cattle in a DFZ and potential collapse of the programme, it would be necessary to ensure that farmers in these two production systems adopt controlled grazing. Ranchers would be willing to pay more for labelling cattle with their identities than without. This reflects the current situation where most ranchers already practice some form of cattle labelling and confined grazing, and suggests that they would fully support traceability of cattle as a key DFZ attribute.

[6] Compensation is not included in the preference ranking because it was entered in the model as a percentage, whereas the other variables were binary.

The implementation of a DFZ would be expected to involve a combination of attributes. To illustrate how farmers in different production systems might respond to different combinations, we derive compensating surplus (CS) estimates (see equation 9) for six possible policy scenarios (Table 6). The CS estimates for all the scenarios considered are positive, suggesting that generally farmers prefer a change from the baseline of no DFZ. However, the CS estimates are significantly different across the three production systems for scenarios 1, 2, 3 and 5, with nomads having the highest CS and agro-pastoralists the lowest. The CS estimates for scenarios 4 and 6 are not statistically different between nomads and ranchers, but higher than for the agro-pastoralists. Generally, nomads and ranchers have higher and similar CS across all DFZ scenarios, while for agro-pastoralists the estimates are much lower. Given that nomads and ranchers derive most of their income from livestock (see Table 2), it might be expected that they are willing to invest more in DFZs. Scenario 4 is the most preferred by farmers in all three production systems. Scenario 2 is the least preferred by the nomads, and scenario 3 the least preferred by both the agro-pastoralists and ranchers. Across and within all three production systems, the CS estimates are higher where the scenarios have an element of training (scenarios 1, 4, 5 and 6). This is consistent with the low levels of formal education and relatively limited access to livestock extension services noted earlier, and further underlines the importance of incorporating training in a DFZ policy design. In addition, scenarios 4 and 6, with larger CS, include market information and contract, which confirms the high preference noted earlier for this attribute (see Table 5).

Selection of a DFZ scenario for implementation will depend on relative resource availability and the priorities of other key stakeholders (e.g., the government). Assuming the unlikely situation of resource abundance and convergence of stakeholder interests towards a ‘one size fits all’ policy, scenario 4 would appear a good choice. Alternatively, the CS estimates could be used together with other practical considerations, e.g. existing institutional capacity and regulatory framework, in choosing a scenario to implement. It might also be worthwhile to consider a phased implementation, starting with the most preferred features and/or production systems where the CS is highest. We envisage that implementation in any area would be administered through a local management committee comprising farmers’ representatives and other stakeholders. This committee would, for instance, identify competitive (public or private) providers of services, such as training, and pay for those services from its account.

Table 6: Attribute levels and compensating surplus for DFZ policy scenarios (in Kshs)

Scenario	Attribute						Compensating surplus in the production systems			
	Training	Market information	Market information and contract	Compensation (%)	Labelling without owner's identity	Labelling with owner's identity	Nomads	Agro-pastoralists	Ranchers	Pooled sample
1	✓	✓		10	✓		2,833.3^{a} (737.8)	1,085.7^{c} (111.3)	2,079.0^{b} (562.0)	1,691.0 (175.7)
2		✓		50		✓	1,941.1^{a} (512.9)	701.5^{c} (79.1)	1,756.6^{b} (463.0)	1,204.9 (128.1)
3			✓	25	✓		1,964.1^{a} (530.7)	631.6^{c} (72.0)	1,636.9^{b} (437.0)	1,102.3 (121.7)
4	✓		✓	25		✓	3,018.6^{a} (775.4)	1,215.8^{b} (117.9)	2,900.1^{a} (745.7)	1,883.9 (185.3)
5	✓	✓		10		✓	2,614.7^{a} (674.8)	1,073.3^{c} (110.9)	2,303.8^{b} (607.0)	1,656.2 (167.5)
6	✓		✓	10		✓	2,793.8^{a} (726.5)	1,131.5^{b} (115.3)	2,715.8^{a} (711.2)	1,747.0 (176.0)

Notes: ✓ indicates the attribute is present in a scenario at the non-zero level.
^{a,b,c} differences in the superscripts denote significant differences, at 5% level, in CS across the production systems.
Standard errors are in parentheses. All CS estimates are significant at 1% level.

5 Conclusions

This study has focused on analysis of farmer preferences for DFZs and provides insights into policy and future research on the design of such programmes. Results show that Kenyan farmers prefer the establishment of effective DFZs in order to help them manage disease challenges in cattle production. Compared to the current disease control programmes, farmers would prefer to have a DFZ in which: they are provided with adequate training on pasture development, record keeping and disease monitoring skills; market information is provided and sales contract opportunities are guaranteed; cattle are properly labelled for ease of identification; some monetary compensation is provided in case cattle die due to severe disease outbreaks. The design of DFZs should therefore include these features to enhance the acceptability of such programmes.

Results also show that there is heterogeneity in farmer preferences across production systems. Because of their relatively high dependence on cattle for income, nomads and ranchers are willing to pay more in order to have market information and contract included in the DFZ. Farmers in these two production systems also have a higher WTP for compensation. There are also variations across the production systems in WTP for training, perhaps due to differences in access to livestock extension and veterinary advisory services and levels of sedentarisation.

In order to ensure acceptance of cattle traceability among the agro-pastoralists and nomads, it appears important to emphasize that inclusion of cattle owner's identity in the labelling is not meant to penalize farmers for trespass, but rather is a key element in enhancing disease control.

Moreover, improving farmers' understanding of the purpose of each attribute is important for a DFZ programme, whose successful implementation requires collective farmer participation.

We also derive farmers' preferences for various DFZ policy scenarios. Across the production systems, there is higher preference for scenarios that incorporate training. The estimates of compensating surplus (along with other factors such as resource availability and stakeholder priorities) should help in choosing the best scenario to implement in a particular system or for the entire cattle sub-sector. Also, appropriate institutional and regulatory frameworks should be established in order to facilitate co-ordination of DFZ services (from public and/or private providers) by the management committee, and to enhance monitoring of implementation.

Future research on DFZs could focus on analysing the total costs and benefits of implementing different DFZ policy scenarios, and possible resource contributions from other stakeholders. Complementary application of orthogonality and efficiency criteria is also deserving of further investigation in improving the statistical appeal of CE designs.

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